AD-A097 768 HUMAN ENGINEERING LAB ABERDEEN PROVING GROUND MD F/G 5/9
THE INCREASING INFLUENCE OF GUNNER LAY ERROR ON FIRST-ROUND HIT--ETC(U)
FEB 81 R M NORMAN, J C GEDDIE
UNCLASSIFIED HEL-TN-2-81 NL

END
DATE
FILMED
5 81
DTIC

Technical Note 2-81

THE INCREASING INFLUENCE OF GUNNER LAY ERROR ON FIRST-ROUND HIT PROBABILITY FOR TANKS

Richard M. Norman
James C. Geddie

February 1981

Approved for public release;
distribution unlimited.

U. S. ARMY HUMAN ENGINEERING LABORATORY

Aberdeen Proving Ground, Maryland

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Technical Note 2-81	2. GOVT ACCESSION NO.: AD-A097 768
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): THE INCREASING INFLUENCE OF GUNNER LAY ERROR ON FIRST-ROUND HIT PROBABILITY FOR TANKS	5. TYPE OF REPORT & PERIOD COVERED: Final
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Richard M. Norman, James C. Geddie	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US Army Human Engineering Laboratory, Aberdeen Proving Ground, MD 21005	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS	12. REPORT DATE: February 1981
	13. NUMBER OF PAGES: 11
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Lay Error
Tank-Gunner Lay Error
First-Round Hit Probability
Lay Error Distribution
Gunner Performance
Human Factors Engineering

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The influence of gunner lay error on first-round hit probability increases as tank system hardware improves. There are valid reasons to question the validity of the data upon which gunner lay error is currently predicted, including the changes in demography and abilities of today's soldier as compared to those of the soldiers who generated the data. Verifying the performance data base seems timely.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Technical Note 2-81

14 HEL-TN-2-81

THE INCREASING INFLUENCE OF GUNNER LAY
ERROR ON FIRST-ROUND HIT PROBABILITY FOR TANKS

Richard M. Norman
James C. Geddie

February 1981

APPROVED: John D. Weisz
JOHN D. WEISZ
Director
U.S. Army Human Engineering Laboratory

U.S. ARMY HUMAN ENGINEERING LABORATORY
Aberdeen Proving Ground, Maryland 21005

CONTENTS

THE INCREASING INFLUENCE OF GUNNER LAY ERROR ON FIRST-ROUND HIT PROBABILITY FOR TANKS

INTRODUCTION

The purpose of this report is to illustrate and discuss the increasing criticality of tank-gunner lay error in first-round hitting probability (P_{H1}).

For some time, the lay error of tank gunners under stress has been represented by the quasi-combat lay error distribution. This is representative of the accuracy of lay for targets of varying exposure and visibility while making tradeoffs with time-to-fire under stress. When user personnel or analysts are briefed, they often inquire about the vintage of the lay error data behind the distribution. One can only assume that they suspect performance differences between the soldiers who generated the data and today's soldier.

The usual response is that any change in lay error would be because of either a difference in motivation or a difference in ability. We try to motivate test participants to succeed and must assume that attempt to be sufficient. (Besides, we don't have a good way to model motivation effects.) As for ability, the human species surely hasn't changed significantly in the 20 years or so since our lay error data were generated.

Does gunner lay error vary from generation to generation? Current models assume that it does not.

There are at least two reasons to question whether the sample of soldiers whose 1953 performance data (1, 2) are still used in predicting P_h are representative of today's soldier and his performance:

1. A larger proportion of mental Category III and IV personnel coming into the Army now may have less well developed sensorimotor skills and probably are slower to acquire them than the soldier population sampled in 1953.

2. A larger proportion of enlistees are from urban areas and from lower socioeconomic groups. They may have a different amount (probably lower) of exposure to firearms, hunting, target practice and tracking experience.

Without a recent validation of the data base used in current models, the question of whether those data are valid for predicting the performance of today's soldier can not be answered directly. The purpose of this report is to emphasize the increasing need for obtaining the answer. Therefore, a series of brief parametric examples will be presented to show the relative levels of P_{H1} dependency on lay error, and on system hardware capability.

EXAMPLES

Parametric values for lay error are presented here only for the stationary firer, stationary target case. The target is the standard vertical target, 2.3 x 2.3 meters (7.5 x 7.5 feet). Two typical tanks are modeled, Tank A and Tank B, representative of 1960s and 1980s fire control hardware technology, respectively. Both fire kinetic energy rounds compatible with their assumed era.

The quasi-combat lay error distribution is a normal distribution with a mean of zero and a standard deviation (S.D.) of:

S.D.(mils) = .3 (meters, converted to mils at range of interest) + .05 mils.

Values of this, in mils, at typical ranges are:

Range (meters)	S.D. (mils)
500	.661
1000	.356
1500	.254
2000	.203
2500	.172
3000	.152

These dispersions apply to both the horizontal and vertical coordinate axes of the target. They are combined with all other biases and dispersions and, using the normal distribution, hit probability is computed.

Lay error was parameterized by simply multiplying the lay error values by the arbitrary multipliers 0.0, 0.5, 1.0, 1.5, and 2.0, with 1.0 representing the lay error data from the early 1950s upon which quasi-combat lay error is based.

DISCUSSION

The output of these computations are shown in Table 1, and also graphically in Figures 1 and 2. The abscissa of each graph is range to the target; the ordinate is first-round hit probability, P_{H1}. The various curves represent how P_{H1} would be influenced as lay error values change from the baseline (1.0 multiple) case. The multiple of 0.0 is for zero lay error. In most weapons, weapon/ammunition round-to-round dispersion (not usually thought of as containing a human element) includes the small lay error incurred by the proving ground gunner involved in the dispersion testing. By using either Table 1 or Figures 1 and 2, the varying influence of lay error, range, and hardware performance can be seen. In general the better the hardware does, the more visible is the effect of varying gunner lay error.

TABLE 1

First-Round Hitting Probability for Multiples of Quasi-Combat Lay Error

Range (Meters)	Multiples of Baseline 0.0	0.5	1.0	1.5	2.0
Tank A					
500	.99	.97	.92	.83	.72
1000	.83	.81	.76	.68	.58
1500	.50	.48	.46	.42	.38
2000	.25	.25	.24	.23	.21
2500	.13	.13	.13	.12	.12
3000	.07	.07	.07	.07	.07
Tank B					
500	1.00	1.00	.99	.94	.82
1000	.98	.97	.92	.83	.70
1500	.85	.82	.76	.67	.57
2000	.66	.63	.59	.52	.45
2500	.49	.48	.45	.40	.35
3000	.37	.36	.34	.31	.27

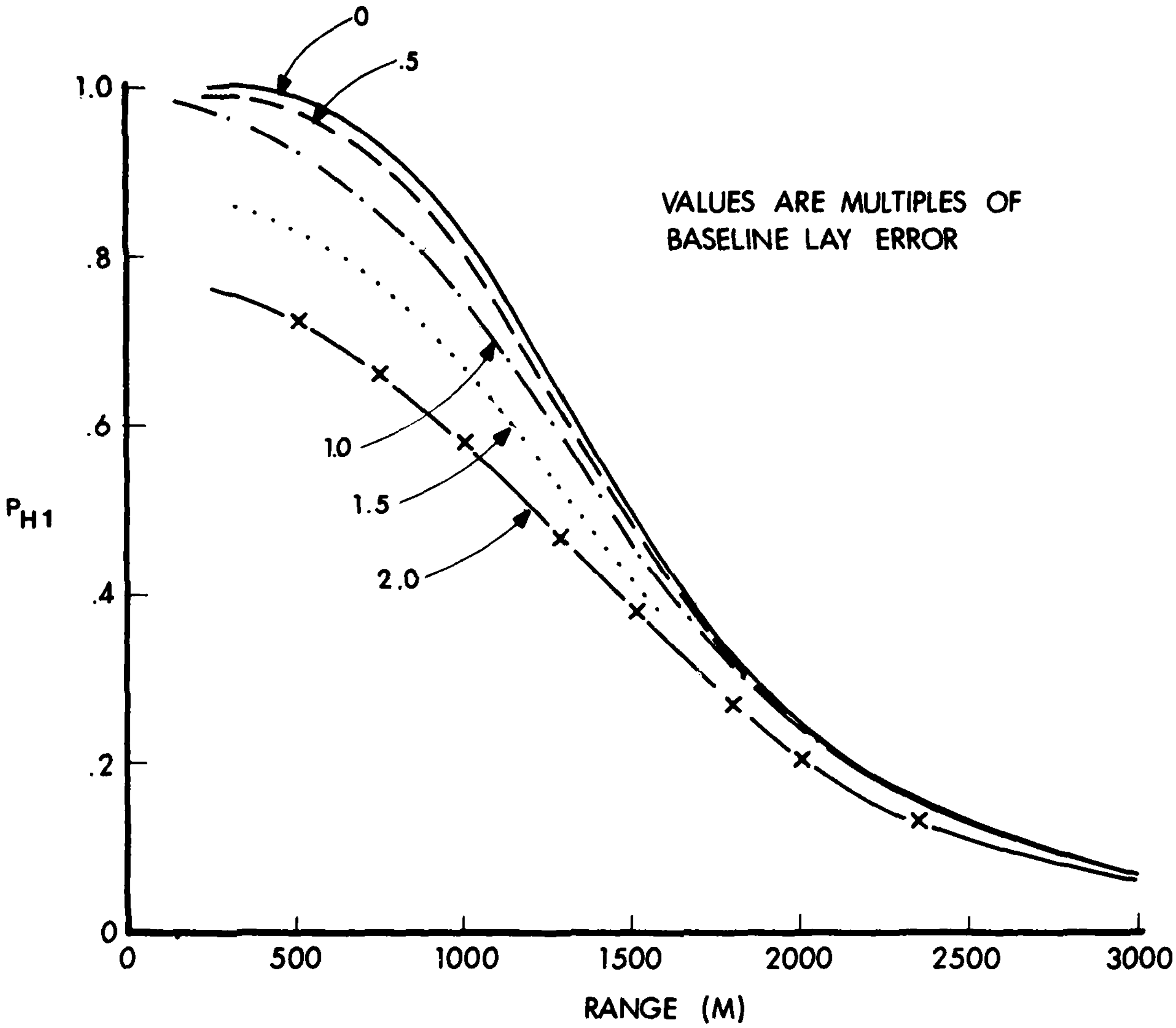

Figure 1. First-round hitting probability (P_{H1}) versus range for Tank A.

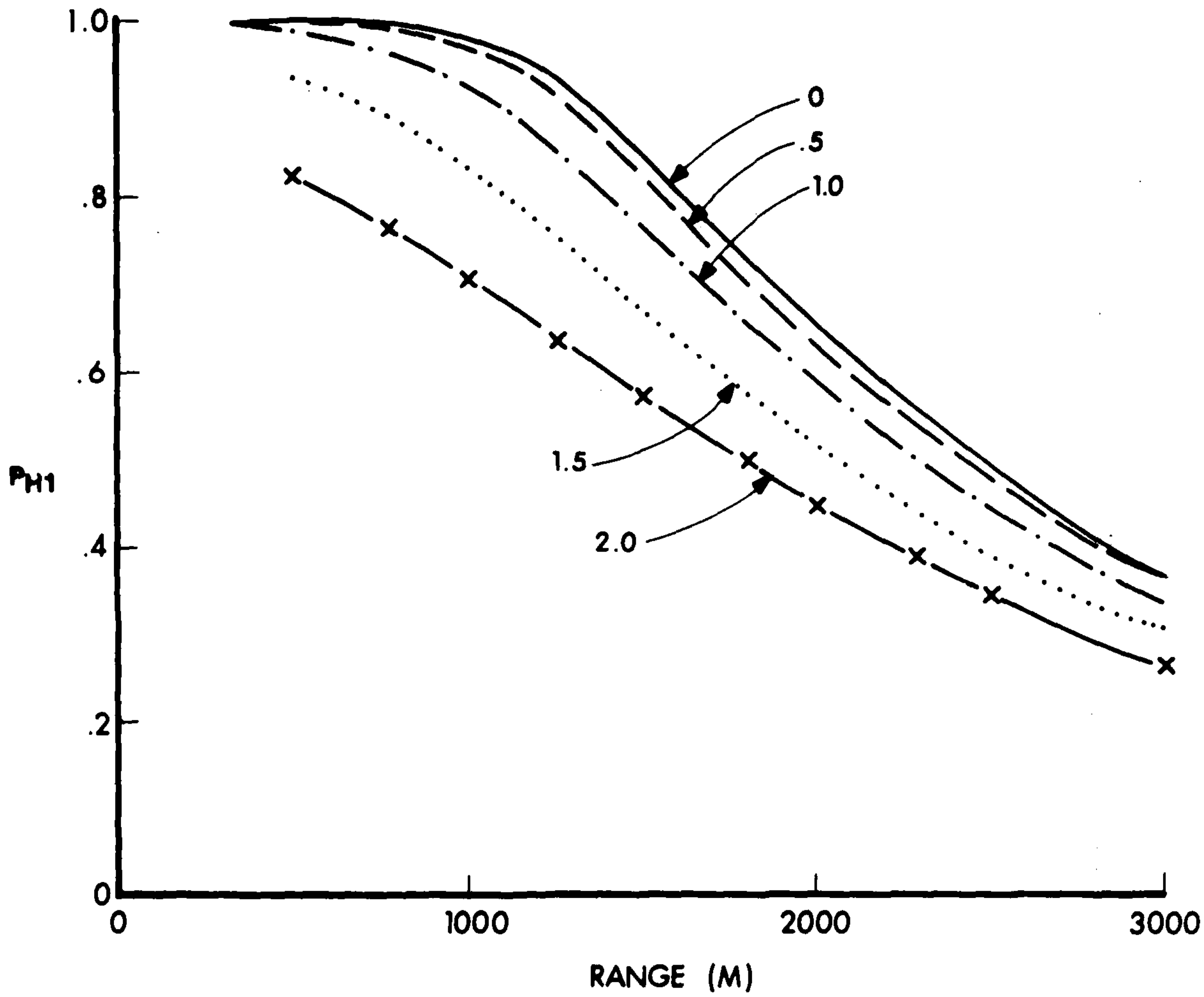

Figure 2. P_{H1} - vs - range for Tank B.

Figures 3 and 4 further illustrate this relationship. The influence of lay error on P_{H1}, at 1500 or 2000 meters, can be seen to be more severe on Tank B than on Tank A. If, today, lay error were reexamined, and found smaller, P_{H1} could be read to the left (on Figure 4 for example) and higher. If lay error were to go larger; however, we read to the right and down, and on a slightly steeper slope.

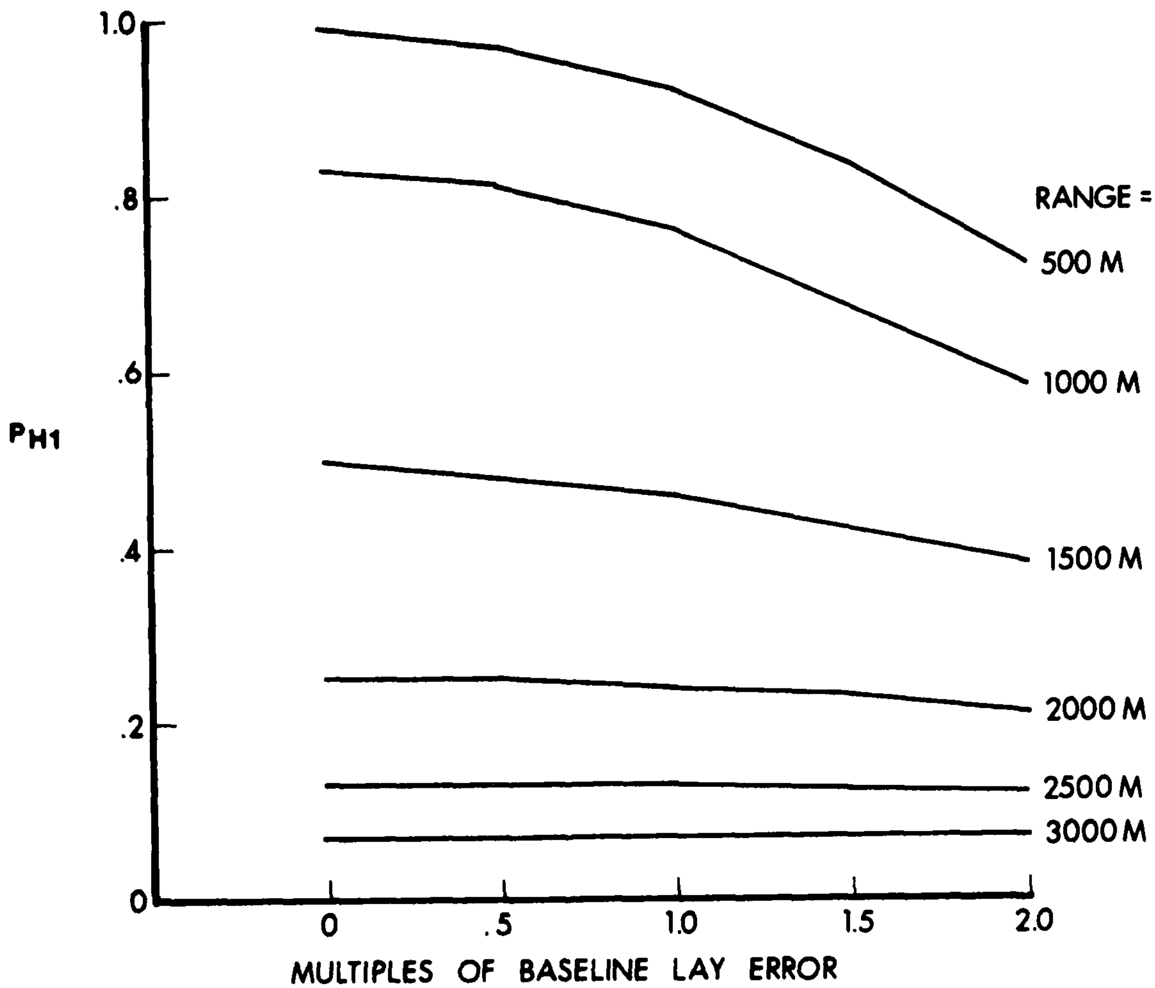

Figure 3. P_{H1} - vs - multiples of quasi-combat lay error for Tank A.

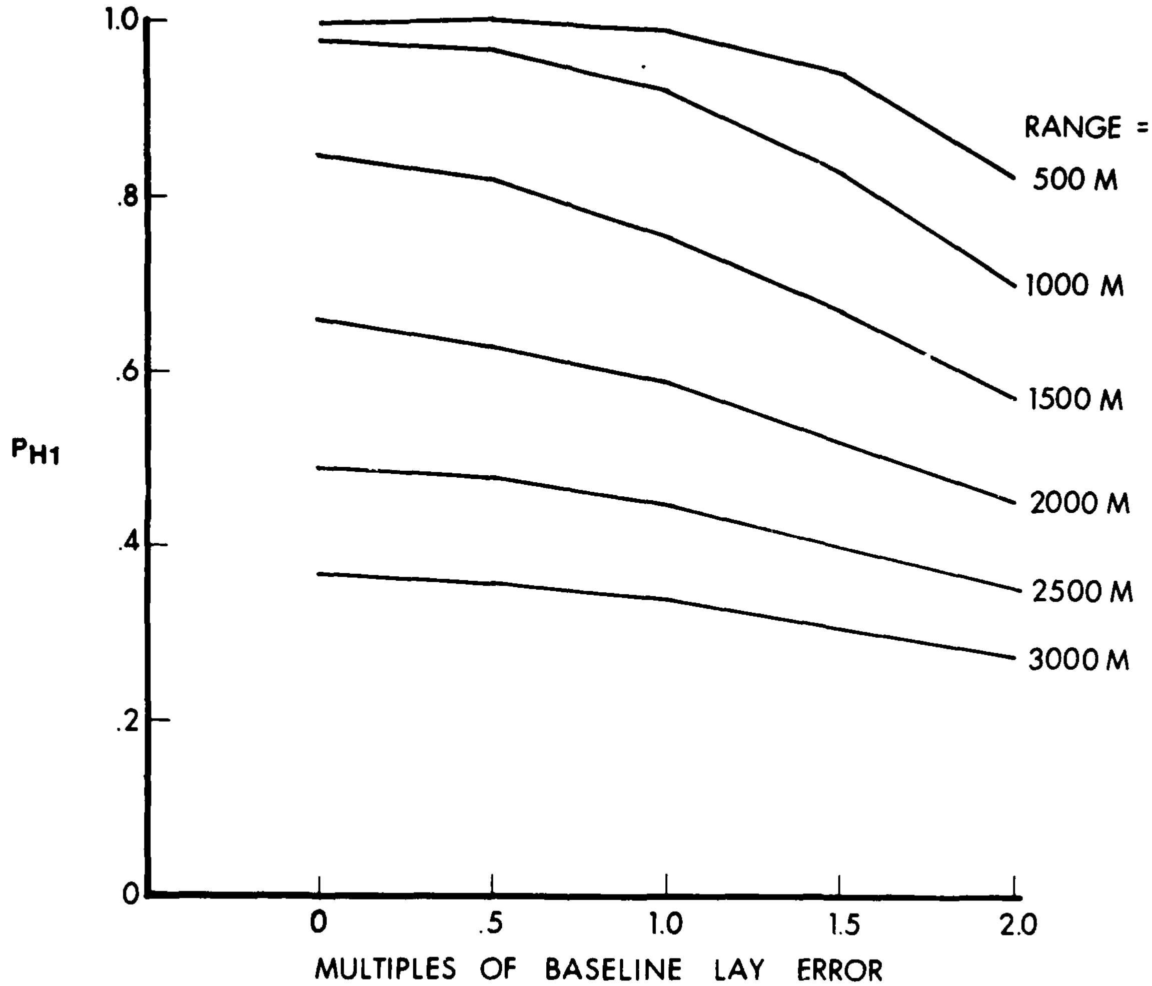

Figure 4. P_{H1} - vs - multiples of quasi-combat lay error for Tank B.

SUMMARY AND CONCLUSIONS

With the passage of time both the possibility of performance changes in the soldier population and the increasing influence of gunner performance on tank hit probability (due to hardware improvements) argue for a revalidation of the 28-year-old data base upon which we model gunner lay error.

REFERENCES

1. Hardison, D., et al. A partial analysis of Project Stalk data with results of single tank versus single tank duels (Technical Note 980). Aberdeen Proving Ground, MD: U.S. Army Ballistic Research Laboratories, February 1955.

2. Hill, F., et al. An assembly of Project Stalk data (Memorandum Report 745) (Volume 3). Aberdeen Proving Ground, MD: U.S. Army Ballistic Research Laboratories, January 1954.

DATE
ILMED

8